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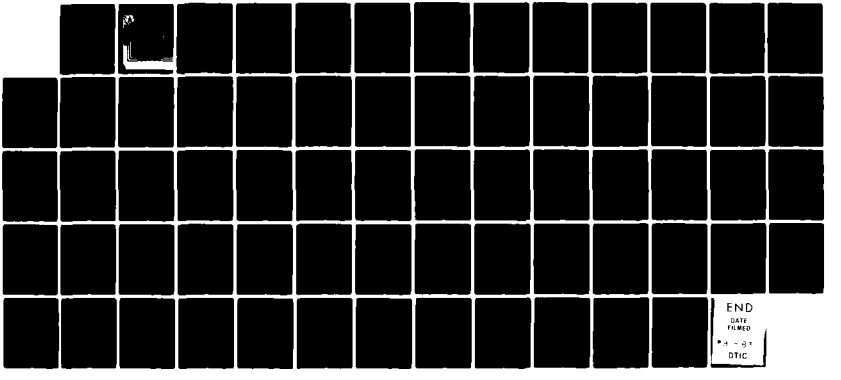

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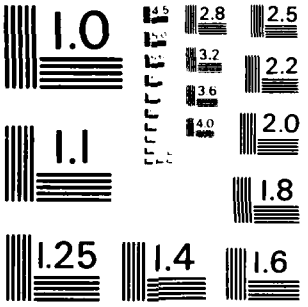

REPORT NO. 83-12

EXTENT OF HEARING LOSS AMONG ARMY AVIATORS AT FORT RUCKER, ALABAMA

By

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August 1983

U.S. ARMY AEROMEDICAL RESEARCH LABORATORY

FORT RUCKER, ALABAMA 36362

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ABSTRACT: This study provided hearing threshold data for Army aviators stationed at Fort Rucker, Alabama, from February through August 1982. The mean pure tone thresholds were found to be improved when compared to data gathered by Walden and McCurdy in 1971. This improvement partially was attributed to redesign of the aviation helmet and increased awareness and compliance with hearing conservation measures. It is possible that tighter administrative controls also contributed to the reduced threshold values. This study further indicated that, for Fort Rucker aviators, there exist three threshold regions correlated with flight hours: 50-400 flight hours, 401-3000 flight hours, and 3001-6000 flight hours. Each region has a specific range of hearing loss measured by comparing 2000 and 4000 Hz thresholds for the left ear. Anyone falling outside the threshold range for her/his respective region could be identified for possible follow-up procedures. .

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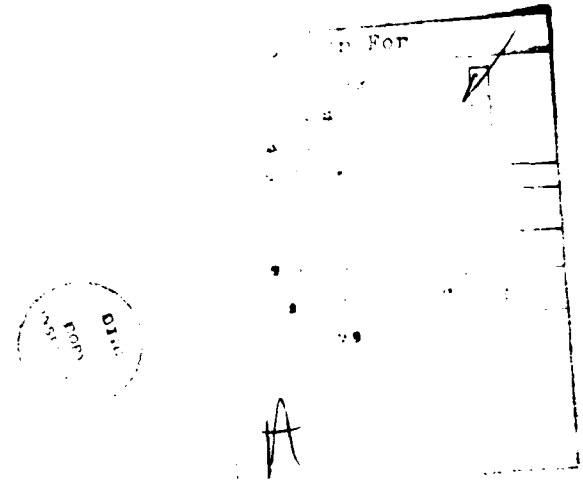

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INTRODUCTION

The Occupational Health Report (AEHA, 1981) states that hearing loss continues as the number one occupational health injury in the Army. Ten years earlier, a survey report (Walden and McCurdy, 1971) identified aviation as a military occupation with a high incidence of hearing loss. The Air Force, as well as the Navy, also has identified their hearing hazardous occupations and the Air Force even has tracked these data by age group (Sutherland and Gasaway, 1978). Although hearing loss long has been associated with the military, the amount of hearing loss per length of exposure never has been reported. This project has attempted to establish a value of hearing loss for a specified number of flight hours.

This study sought to quantify the extent of hearing loss among aviators at Fort Rucker, Alabama, and to identify factors which may have contributed to this loss. Standard audiometric test procedures and questionnaire techniques were used in a stratified random sample approach. Values found in this study can serve as initial normative hearing threshold levels distributed by flight hours. This is important because it is not possible to discuss risk and excess hearing loss by flight hours until a norm is established among rotary wing aviators. This study also should provide insight into the effect the SPH-4 flight helmet has had on the reduction of noise-induced hearing loss.

METHODS AND MATERIALS

A listing of permanent party military aviators was provided by the Automation Management Office (AMO) at Fort Rucker. These printouts indicated that 98 percent of Fort Rucker's military aviators could be placed in a range between 50 and 7600 flight hours. A stratified random sample (Table 1) was developed by separating this military aviation population into 10 cells or strata according to flight hours. To obtain a confidence interval of 95 percent, a N of 145 was selected using a standardized sampling scheme (Cochran, 1977). The weight which each stratum represented to the total population was determined (Table 1). These individual stratum weights then were multiplied by the number of aviators assigned to each stratum, resulting in n_h, the required sample size of each stratum. (Appendix A lists the population distribution by stratum.) Aviators selected at random were asked to fill out a questionnaire and take a hearing test as a part of their scheduled flight physical. The questionnaire (Appendix B) attempted to identify a subject's hearing history and exposure to hazardous noise. Although an audiologist or technician reviewed each questionnaire to eliminate obvious errors or omissions, the questionnaire data should be considered subjective in nature and only the best recollection of the subject.

A pure tone threshold audiometric test was administered to each subject using either a Grason-Stadler Audiometer Model 1701 with TDH 49 earphones or

TABLE 1

WEIGHTED SAMPLE DISTRIBUTION

Strata (by flight hrs) h Stratum Number	Flight Hours	Number in Stratum N_h	Number in Sample n_h	Sampling Fraction in Stratum f_h	Stratum Weight W_h
1	50-400	63	9	0.1428	0.0596
2	401-600	47	8	0.1702	0.0445
3	601-800	52	8	0.1538	0.0492
4	801-1000	72	10	0.1389	0.0682
5	1001-2000	296	27	0.0912	0.2803
6	2001-3000	229	37	0.1616	0.2168
7	3001-4000	168	26	0.1548	0.1591
8	4001-5000	85	13	0.1529	0.0805
9	5001-6000	35	5	0.1428	0.0332
10	6001-7000	9	2	0.2222	0.0086
	TOTAL	1056	145	0.1373	1.0000

Grason-Stadler GSI 10 with TDH 50P earphones. The audiometers had received electro-acoustic calibrations in accordance with American National Standards Institute (ANSI) S3.6-1969 prior to the start of the survey. In addition, daily biological listening checks (self-administered audiometric tests to insure consistent audiometric output) were performed by examiners prior to testing during the conduct of the survey. All hearing thresholds were obtained using the Carhart-Jerger preferred clinical method of threshold determination (Carhart and Jerger, 1959) with the subjects seated in a double-walled IAC sound-treated audiometric examination booth.

French and Steinberg (1947) demonstrated that speech signals above 2500 Hz do not significantly improve speech intelligibility in quiet. However, in noise lower frequency speech components are masked by competing background signals and the higher frequencies become more important. Since high levels of background noise exposure result in high frequency hearing loss and signals below 2000 Hz easily are masked, this study limited its investigation to 2000, 3000, 4000, and 6000 Hz bilaterally.

Questionnaire results and threshold values were stored in a Systems Engineering Laboratories Model 86 Digital Computer. All data were double-checked to eliminate any entry errors and then sorted for analysis.

The analysis of data considered mean and median threshold levels, standard deviations, and standard errors as a function of flight hours. Questionnaire and threshold data then were tabulated.

RESULTS AND DISCUSSION

Hearing threshold data for all subjects are summarized in Table 2. In general, increased flight hours are associated with an increase in hearing loss, with the greatest loss occurring at 6000 Hz in pilots with 3001-4000 flight hours: 34 dB in the right ear.

Table 3 lists the relationship between flight hours, age, years in service and years rated as an aviator. With this information, it was determined that aviators with over 3000 hours (Table 3) had, on the average, more than 10 years as a rated aviator. Results from a 1971 US Army survey (Walden and McCurdy, 1971) which recorded threshold data for aviators with over 10 years rated service then were compared (Table 4) with the threshold data for the 10 years plus aviators from the current study.

As indicated by Table 4, mean hearing threshold levels appear to be lower for today's aviators than for those of a decade ago. This could be the result of complex factors which include the redesign of aviator helmets and increased emphasis on hearing conservation. The difference in sample populations may be a contributing factor in any attempt to view Table 4 as displaying absolute reduction levels. However, this population variation is not felt to be significant in identifying a trend.

TABLE 2
N=145

MEASURES OF CENTRAL TENDENCY AND DISPERSION FOR HEARING THRESHOLDS BY FLIGHT HOURS

Frequency		n=9 50-400 Hrs L	n=9 50-400 Hrs R*	n=8 401-600 Hrs L	n=8 401-600 Hrs R	n=8 601-800 Hrs L	n=8 601-800 Hrs R	n=10 801-1000 Hrs L	n=10 801-1000 Hrs R
2000 Hz	Mean	10.6	5.6	4.4	2.5	3.1	0	7.5	4.0
	Median	5.0	5.0	2.5	0	0	0	7.5	5.0
	S.D.	10.1	8.1	5.6	5.3	4.6	0	5.9	3.9
	S.E.	5.8	2.9	2.9	1.4	2.9	0	1.4	1.4
3000 Hz	Mean	12.2	5.6	11.3	6.9	8.8	7.5	6.0	5.5
	Median	5.0	5.0	7.5	5.0	10.0	5.0	5.0	5.0
	S.D.	17.0	5.8	14.6	7.5	9.9	9.6	6.1	2.8
	S.E.	4.3	2.9	4.3	4.3	2.9	2.9	2.9	0
4000 Hz	Mean	10.0	7.2	14.4	8.1	13.1	7.5	11.5	7.5
	Median	5.0	0	15.0	7.5	12.5	5.0	12.5	5.0
	S.D.	16.2	10.6	12.9	8.0	9.2	3.8	7.1	7.5
	S.E.	4.3	4.3	8.7	2.9	4.3	1.4	2.9	1.4
6000 Hz	Mean	10.6	22.2	11.3	13.8	10.6	16.3	17.0	18.5
	Median	5.0	15.0	10.0	12.5	10.0	15.0	12.5	15.0
	S.D.	10.7	19.2	6.4	12.5	9.0	11.3	11.6	11.6
	S.E.	4.3	8.7	2.9	4.3	2.9	2.9	2.9	5.8

*The L and R denote the left and right ears, respectively.

S.D.=Standard Deviation
S.E.=Standard Error of the Mean

TABLE 2 (CONTINUED)

Frequency		n=27 1001-2000 Hrs L	n=27 1001-2000 Hrs R*	n=37 2001-3000 Hrs L	n=37 2001-3000 Hrs R	n=25 3001-4000 Hrs L	n=25 3001-4000 Hrs R	n=13 4001-5000 Hrs L	n=13 4001-5000 Hrs R	n=5 5001-6000 Hrs L	n=5 5001-6000 Hrs R
2000 Hz	Mean	6.1	7.9	6.2	6.9	7.2	8.0	4.2	7.7	6.0	6.0
	Median	5.0	0	5.0	5.0	5.0	5.0	5.0	5.0	0	5.0
	S.D.	9.6	11.4	5.6	7.6	9.6	8.4	4.0	10.1	10.8	6.7
	S.E.	1.4	2.9	1.4	0	2.9	1.4	1.4	2.9	7.2	4.3
3000 Hz	Mean	16.3	13.7	10.9	10.9	17.7	17.0	10.4	13.5	13.0	7.0
	Median	10.0	10.0	5.0	5.0	15.0	15.0	5.0	5.0	10.0	5.0
	S.D.	17.1	15.0	11.9	11.6	13.6	13.0	11.4	17.7	10.4	5.7
	S.E.	2.9	2.9	1.4	1.4	2.9	2.9	5.8	2.9	7.2	4.3
4000 Hz	Mean	18.5	15.4	18.5	15.1	25.4	22.0	24.6	17.3	25.0	9.0
	Median	10.0	10.0	15.0	10.0	15.0	15.0	20.0	10.0	20.0	10.0
	S.D.	16.9	17.8	16.7	17.1	21.0	19.9	17.7	18.1	20.0	7.4
	S.E.	2.9	2.9	2.9	2.9	5.8	5.8	5.8	7.2	15.9	5.8
6000 Hz	Mean	15.9	18.3	23.1	24.5	23.3	34.3	21.5	30.0	14.0	25.0
	Median	10.0	15.0	20.0	20.0	20.0	25.0	15.0	20.0	10.0	20.0
	S.D.	14.7	16.1	22.1	20.0	20.6	24.6	19.3	24.8	8.2	17.7
	S.E.	4.3	2.9	4.3	4.3	2.9	4.3	5.5	7.2	5.8	13.0

*The L and R denote the left and right ears, respectively.

S.D.=Standard Deviation
S.E.=Standard Error of the Mean

TABLE 3
AVIATOR AGE, YEARS RATED, AND YEARS IN SERVICE AS A FUNCTION OF FLIGHT HOURS
AVIATOR BACKGROUND DATA

Stratum in Flight Hrs	Flight Hrs		Age		Years in Service		Years Rated As Aviator	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
50-400	315.4	115.0	27.2	3.5	4.4	3.4	1.6	1.0
401-600	486.0	66.2	27.8	2.5	5.1	3.2	1.8	0.9
601-800	713.1	59.5	28.5	4.0	6.5	3.5	3.5	2.5
801-1000	921.4	83.9	31.4	4.4	9.3	3.8	6.6	3.5
1001-2000	1524.2	291.4	31.2	4.0	9.7	3.6	6.9	3.1
2001-3000	2539.4	343.4	33.5	4.7	12.3	3.8	9.9	4.2
3001-4000	3423.8	309.1	34.3	4.4	13.5	3.2	12.3	3.3
4001-5000	4470.8	242.3	35.3	4.7	13.7	2.6	11.8	3.4
5001-6000	5198.0	150.1	37.0	3.5	14.8	3.3	13.6	3.6
6001-7000	7000.0	0	37.0	2.8	18.0	1.4	15.0	1.4

TABLE 4

1982 VERSUS 1971 HEARING THRESHOLD COMPARISONS IN dB FOR AVIATORS WITH AT LEAST TEN YEARS AS A RATED AVIATOR

	Right Ear			Left Ear		
	2000 Hz	4000 Hz	6000 Hz	2000 Hz	4000 Hz	6000 Hz
Mean Threshold 1971 Survey n=43 (Total flight hours unknown)	11.0	30.7	32.8	11.2	31.0	27.7
Mean Threshold 1982 Survey n=46 (Aviators with 3000-7000 hours)	6.5	17.7	32.3	6.4	25.6	22.6

As further evidence of a reduction in hearing loss, Table 5 compared mean threshold data by age against thresholds reported by the U.S. Public Health Service (USPHS, 1965) study of the general nonindustrial civilian population. Not until the 5th stratum (1001-2000 flight hours) did mean hearing threshold values for Army aviators significantly exceed the civilian normative data. This excess probably was due in part to the aircraft noise environment in combination with small arms and artillery exposure. These results were similar to a 1978 US Air Force study (Sutherland and Gasaway, 1978) which found that Air Force aviation personnel reflected better hearing than either noise-exposed Air Force civilians or the general U.S. population.

Table 2 (threshold data) also indicated a greater amount of mean hearing loss in the left ear than the right ear from 2000 through 4000 Hz. At 6000 Hz the right ear exhibited the most damage. These results held true for all categories of flight hours. This result has not been reflected in the literature; other studies (Corso, 1963; Spoor, 1967) did not report the ear involvement to be frequency dependent, but indicated rather that the left ear most consistently was involved. However, a one-way analysis of variance of all frequencies (2, 3, 4, and 6 kHz) did not find the threshold differences between ears significant at the .05 level.

Table 6 displays the difference in dB between 2000 and 4000 Hz for the left ear broken out by flight hours. This table indicates an increase in threshold between the 50-400 and 401-600 flight hour strata and again between the 2001-3000 and 3001-4000 strata. The 4 dB difference for 801-1000 flight hours was felt to be artificially low due to the high incidence of exposure to weapons fire: eight out of 10 subjects had been exposed to significant small arms or artillery fire. It was felt that this greater than normal exposure elevated thresholds for 2000 Hz as well as 4000 Hz and thus artificially reduced the expected range. One-way analysis of variance did not find a significant difference for threshold values among strata at the .05 level for either 2000 or 4000 Hz. However, a one-way analysis of variance of difference scores (4000 Hz threshold minus 2000 Hz threshold) did find a significant effect of flight hour strata ($F=2.5$, $dF=135$, $p<.05$).

Questionnaire data concerning the 145 aviators who participated in this study were reviewed and although all data were entered into the computer, only selected items are reported in Appendix C (Data and Summary Statistics). This decision was based on the fact that most of the questionnaire items could not be verified and represented only the best recollection of the subject.

Flight hours, rank, and age were the administrative questionnaire items selected for analysis. Rank was found to be heavily polarized - 69 percent of the sample population (57/83) with more than 2000 flight hours were warrant officers. Of subjects with less than 2000 flight hours, 85 percent (53/62) were found to be officers. The age of the 145 subjects ranged from 24 to 45 with a mean of 32 years.

TABLE 5
MEAN THRESHOLD COMPARISON
UPIC 1968 (CIVILIAN IDI RANGE: 25-34) VERSUS 1982 US ARMY AVIATORS AT FT RUCKER (AVERAGE MILITARY AGE: 32)

Frequency	1968 Civilian Threshold Levels		Flight Hours 50-400		Flight Hours 401-600		Flight Hours 601-800		Flight Hours 801-1000		Flight Hours 1001-2000	
	L	R*	L	R	L	R	L	R	L	R	L	R
2000 Hz	11.8	11.0	10.6	5.6	4.4	2.5	3.1	6	7.5	4.0	6.1	7.9
3000 Hz	13.2	10.5	12.2	5.6	11.3	6.9	8.8	7.5	6.0	5.5	16.3	13.7
4000 Hz	17.0	14.9	10.0	7.2	14.8	8.1	13.1	7.5	11.5	7.5	18.5	15.4
6000 Hz	19.3	17.6	10.6	22.2	11.3	13.8	10.6	16.3	17.0	18.5	15.9	18.3

* The L and R denote the left and right ears, respectively.

TABLE 5 (CONTINUED)

Frequency	UPHS Civilian Threshold Levels		Flight Hours 2001-3000		Flight Hours 3001-4000		Flight Hours 4001-5000		Flight Hours 5001-6000	
	L	R*	L	R	L	R	L	R	L	R
2000 Hz	11.8	11.0	6.2	6.9	7.7	6.2	4.2	7.7	6.0	8.0
3000 Hz	13.2	10.5	10.9	10.9	17.7	11.9	10.4	13.5	13.0	7.0
4000 Hz	17.0	14.9	18.5	15.1	25.4	20.0	24.6	17.3	25.0	9.0
6000 Hz	19.3	17.6	23.1	24.5	23.3	34.8	21.5	30.0	14.0	25.0

*The L and R denote the left and right ears, respectively.

TABLE 6

MEAN THRESHOLD DIFFERENCE IN dB BETWEEN 2000 AND 4000 HZ IN THE LEFT EAR

	n = 9	n = 8	n = 8	n = 10	n = 27	n = 37	n = 26	n = 13	n = 5
Flight Hours	50-400	401-600	601-800	801-1000*	1001-2000	2001-3000	3001-4000	4001-5000	5001-6000
	0.6	10.0	10.0	4.0	12.4	12.3	17.7	20.4	19.0

*Eight out of the ten subjects had significant exposure to small arms and artillery.

Questionnaire items No. 7 (earplugs worn with the helmet), No. 16 (years exposed to small arms), No. 17 (years exposed to artillery), and No. 28 (years smoked), are tabulated in Appendix C. The following is a summary of the self-reported responses to these items: 39 aviators, or 27 percent, of the sample population admitted to wearing earplugs with the SPH-4 helmet. Seventy-one aviators, or 49 percent, had at least one year of frequent exposure to small arms fire and 56, or 39 percent, had received frequent exposure to artillery fire for at least one year. Smoking was defined as the use of one-half package of cigarettes a day for at least one year. Using this criterion, only 40 pilots, or 28 percent, were identified as smokers.

CONCLUSION

This study provided hearing threshold data for Army aviators stationed at Fort Rucker, Alabama, from February through August 1982. This population displayed the following characteristics: nonsmoking, 72 percent; average age, 32; earplugs typically not worn with SPH-4 helmets, 73 percent; and substantial exposure to small arms and artillery fire, 54 percent.

Three major findings emerged from the threshold data. The present mean pure-tone thresholds were found to be lower than data gathered by Walden and McCurdy in 1971. The authors speculate that this improvement can be attributed to redesign of the SPH-4 helmet and increased awareness of and compliance with hearing conservation measures. It is possible that tighter administrative controls also contributed to the reduced threshold values through the elimination of aviators who failed to meet the criteria required to remain on flight status.

The second finding, that the threshold values for the right ear exceeded those for the left ear at 6000 Hz across all strata of flight hours, cannot be readily explained. This result may be peculiar to the aircraft's acoustic environment.

Perhaps most important was the finding of three threshold regions which may have possible use as discriminators to highlight the individual who has increased susceptibility to noise damage. Currently, a 20 dB elevation in threshold is used to indicate a significant threshold shift in hearing acuity. The data from this study indicated that, for Army aviators at Fort Rucker, there exist three threshold regions correlated with flight hours: 50-400 flight hours, 401-3000 flight hours, and 3001-6000 flight hours. These regions each have a specific range of hearing loss measured by comparing 2000 and 4000 Hz thresholds in the left ear. These normative data establish an expected amount of hearing loss according to the amount of flight hours. Therefore, anyone falling outside of his/her respective range could be identified for possible follow up procedures prior to incurring a 20 dB shift.

RECOMMENDATION

It is recommended that additional studies be undertaken to enlarge the data base for the aviation population. Similar 2000-4000 Hz range results from an enlarged sample would serve to validate the initial normative data and allow hearing threshold levels to be predicted. Aviators exceeding those predictor values would be considered "at risk" and follow-up procedures would be recommended prior to the onset of a significant threshold shift.

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APPENDIX A

Fort Rucker Aviation Population and Sample Size

APPENDIX A

FORT RUCKER AVIATION POPULATION AND SAMPLE SIZE

Item	Strata in Flight Hours	N*	N	n**
		February 1982	August 1982	
1	50-400	70	63	9
2	401-600	54	47	8
3	601-800	55	52	8
4	801-1000	70	72	10
5	1001-2000	195	296	27
6	2001-3000	256	229	37
7	3001-4000	177	168	26
8	4001-5000	83	85	13
9	5001-6000	32	39	5
10	6001-7000	11	9	2
	TOTALS:	1003	1060	145

* Total population.
** Sample (based on February, 1982 totals).

APPENDIX B

Army Aviator Questionnaire

APPENDIX B

EXTENT OF HEARING LOSS

The purpose of this survey is to determine the extent of hearing loss among Army aviators. None of the information that you provide will become a part of your medical record. Your name will not be indicated anywhere on the questionnaire or in the analysis of the data.

Please answer the following questions as accurately as possible. Your participation in this survey is greatly appreciated.

NAME:_____

Subject Number:_____

Current Duty Station:_____

Unit:_____

Phone:_____

SURVEY CONTROL NUMBER AFIT-NOR-MS-81-26

EXTENT OF HEARING LOSS AMONG ARMY AVIATORS
QUESTIONNAIRE

Subject number _____(AAA)

Age in Years_____(BB) Months_____(CC) Time in Service Years____(DD) Months_____(EE)

1. Military Rank _____(FF) 1-4 = WO1-CW4 5 = 2LT 6 = 1LT 7 = CPT 8 = MAJ 9 = LTC 10 = COL

2. What branch of service. Please check one. (G)

Armor_____(1) Artillery_____(2) Infantry____(3) Transportation____(4)

Other (please specify)_____(5)-Chem; 6=MP; 7=MED; 8=AVN; 9=SIG

3. How many years have you been rated as a US Army Aviator? _____(HH)

4. Total number of flight hours logged:_____(IIII)

5. Approximate number of hours of flight time logged in nonmilitary aircraft_____(JJJJ)

6. What type of nonmilitary aircraft have you flown, for how many hours, and what type of hearing protectors have you worn?

1-Single eng; 2-twin eng; 3-four eng; 4-helicopter

Plane	Time/Hours	Hearing Protection Worn					
(K)	(LLLL)	(1)	(2)	(3)	(4)	(5)	(M)
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	

7. What type of military aircraft have you flown, for how many hours, and what type of hearing protection have you worn?

1=UH1; 2=AH1; 3=CH47; 4=OH58; 5=OH13; 6=TH55, 7=OH6; 8=T41; 9=T42; 10=01; 11=U21; 12=CH54

Plane	Time/Hours	Hearing Protection Worn					
(N)	(OOOO)	(1)	(2)	(3)	(4)	(5)	(P)
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	
_____	_____	____SPH-4	____Headset	____Earplug	____SPH-4/Earplug	____None	

8. How many years have you been flying US Army aircraft? _____(QQ)

9. What type of military gunship aircraft have you flown, for how many hours, and what type of hearing protection have you worn?

Plane	Time/Hours	Hearing Protection Worn					
(RR)	(SSSS)	(1)	(2)	(3)	(4)	(5)	(T)
_____	_____	___SPH-4	___Headset	___Earplug	___SPH-4/Earplug	___None	
_____	_____	___SPH-4	___Headset	___Earplug	___SPH-4/Earplug	___None	
_____	_____	___SPH-4	___Headset	___Earplug	___SPH-4/Earplug	___None	
_____	_____	___SPH-4	___Headset	___Earplug	___SPH-4/Earplug	___None	

10. How many years have you routinely worn the SPH-4 flight helmet?_____(UU)

11. Have you ever worked in a noise hazardous environment (driving tractors, wood working, around noisy machinery) without wearing hearing protection? Yes___(1) No___(2) (V)

12. Do you ususally wear hearing protection (earplugs or earmuffs) when exposed to noise hazardous work environment? Yes_____(1) No_____(2) (W)

13. How many years have you routinely worn hearing protectors (earplugs or earmuffs) in a noise hazardous work environment (power tool, driving tractors, wood working, cockpit, flight line)? _____(XX)

14. Is hearing protection other than the SPH-4 flight helmet usually available to you when you are exposed to a noise hazardous situation on the flight line? Yes___(1) No___(2) (Y)

15. How long ago was your last noise hazardous exposure (flight line) in hours_____(ZZ), days_____(AA), months_____(BB).

16. How many years have you had a military assignment involving frequent (at least monthly) exposure to small arms fire? None_____ Years_____(CC)

17. How many years have you had a military assignment involving frequent (at least monthly) exposure to artillery weapons fire? None_____ Years_____(DD)

18. How many years have you been routinely exposed to aircraft radio communication? _____(EE)

19. When was your last exposure to aircraft radio communication in hours?____(FF), days_____(GG), months_____(HH).

20. Do you believe that you presently have a hearing loss? Yes_____(1) No___(2) (I).

21. How many years have you experienced a hearing loss?_____(JJ).

22. Does your hearing loss sometimes interfere with your ability to hear and understand radio communication? Yes_____(1) No____(2) (K).

23. In the communication situations listed below, circle the degree of difficulty (1,2,3,4) you experience for each situation.

1 = No difficulty
2 = Minimal difficulty
3 = Some difficulty
4 = Great difficulty

a. In a crowd: 1 2 3 4 (L)

b. In a small gathering of two or three people: 1 2 3 4 (M)

c. In a conversation with another individual: 1 2 3 4 (N)

d. While using the aircraft radio communication system: 1 2 3 4 (O)

e. In your office environment: 1 2 3 4 (P)

f. Using the telephone: 1 2 3 4 (Q)

24. Does your hearing loss sometimes interfere with your ability to function in social situations? Yes_____(1) No_____(2) (R)

25. Does your hearing loss sometimes interfere with your ability to perform your job to the best of your ability? Yes _____(1) No_____(2) (S)

26. What do you believe was the primary cause of your hearing loss? Check one. (TT)

_____(1) Exposure to small arms fire
_____(2) Exposure to artillary weapons fire
_____(3) Exposure to aircraft radio communication
_____(4) Exposure to noisy machines or engines
_____(5) Exposure to aircraft engine noise
_____(6) Ear disease
_____(7) Aging
_____(8) Illness
_____(9) Do not know
_____(10) Other (please specify)

27. Do you believe your hearing loss developed over an extended period of time (years) or as a result of a traumatic exposure (gunblast)?

Extended period_____(1) Traumatic exposure_____(2) (U)

28. Do you smoke cigarettes? Yes_____ No_____ circle how many packs of cigarettes you smoke per day: (1) ½ (2) 1 (3) 1½ (4) 2 (5) 2½ (V)

29. Circle how frequently you change the earcup seals on your SPH-4 flight helmet: (W)

(1) 6 months (2) 12 months (3) 18 months (4) 24 months (5) 36 months

30. Circle when you last changed the earcup seals on your SPH-4 flight helmet.

(1) 6 months (2) 12 months (3) 18 months (4) 24 months (5) 36 months

31. **AUDIOGRAM**

Frequencies

	500 RR5	1000 RR1	2000 RR2	3000 RR3	4000 RR4	6000 RR6	8000 RR8
Right							
Left							
	LL5	LL1	LL2	LL3	LL4	LL6	LL8

32. Approximately how many years have you had frequent (at least every 3 months) exposure to nonmilitary handguns, rifles, or shotguns? None_____ Years_____ (MM)

33. Check the type of nonmilitary small arms you have been exposed to as a child and/or adult and what type of hearing protection you utilize?

Type Weapon			Hearing Protection Worn					
	Yes	No	Earplug	Earmuff	Earplug/earmuff	None	Sometimes	
Handgun	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	___ 7	(N)
Rifle/shotgun	___ 1	___ 2	___ 3	___ 4	___ 5	___ 6	___ 7	(O)

33. How many years have you smoked_____(PP)

(1) 0 (2) 1-5 (3) 5-10 (4) 11-15 (5) 16-20 (6) 21-25 (7) 26-30

APPENDIX C

Data and Summary Statistics

APPENDIX C
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 1st STRATUM
(50-400 Flight Hours, n=9, N=63)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
47	400	30	10	55	10	50	30	35	65
95	400	5	5	5	10	5	15	5	10
96	280	5	5	5	5	0	0	10	15
125	360	0	0	0	0	0	0	20	20
128	269	5	0	5	15	0	0	5	15
133	400	25	25	15	10	5	15	5	20
146	400	10	0	10	0	15	0	5	15
147	50	5	0	0	0	0	0	0	0
148	280	10	5	15	0	15	5	10	40
Sum	2839	95	50	110	50	90	65	95	200
Mean	315.0	10.6	5.6	12.2	5 6	10.0	7.2	10.6	22.2
S.D.	115.0	10.1	8.1	17.0	5.8	16.2	10.6	10.7	19.2
Maximum	400	30	25	55	15	50	30	35	65
Minimum	50	0	0	0	0	0	0	0	0
Median	360.0	5.0	5.0	5.0	5.0	5.0	0	5.0	15.0
Median, S.D.	37.8	5.8	2.9	4.3	2.9	4.3	4.3	4.3	8.7

* Identified by subject number.
** The R and L denote the right and left ears, respectively.

APPENDIX C

SUBJECT BACKGROUND DATA FOR THE 1st STRATUM
(50-400 Flight Hours, n=9, N=63)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
47	CPT	28	400	0	4	No	4
95	1LT	24	400	0	0	No	0
96	2LT	24	280	0	0	No	0
125	1LT	34	360	0	0	No	0
128	1LT	24	269	0	0	No	0
133	CPT	30	400	0	0	No	0
146	1LT	24	400	0	0	Yes	0
147	2LT	26	50	0	0	No	3
148	CPT	28	280	0	1	No	3

APPENDIX C
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 2nd STRATUM
(401-600 Flight Hours, n=8, N=47)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
22	500	0	0	5	5	5	10	5	20
23	500	15	15	15	15	15	10	25	40
39	475	0	0	10	5	15	25	5	5
129	600	0	0	5	0	15	5	10	10
131	420	0	0	0	0	0	0	10	5
132	435	5	0	0	0	0	0	10	0
135	550	5	0	45	20	35	10	15	15
145	408	10	5	10	10	30	5	10	15
Sum	3888	35	20	90	55	115	65	90	110
Mean	486.0	4.4	2.5	11.3	6.9	14.4	8.1	11.3	13.8
S.D.	66.2	5.6	5.3	14.6	7.5	12.9	8.0	6.4	12.5
Maximum	600	15	15	45	20	35	25	25	40
Minimum	408	0	0	0	0	0	0	5	0
Median	488.0	2.5	0	7.5	5.	15.	7.5	10.0	12.5
Median, S.D.	37.5	2.9	1.4	4.3	4.3	8.7	2.9	2.9	4.3

* Identified by subject number.
** The R and L denote the right and left ears, respectively.

APPENDIX C

SUBJECT BACKGROUND DATA FOR THE 2nd STRATUM
(401-600 Flight Hours, n=8, N=47)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
22	CPT	30	500	0	0	No	3
23	CPT	28	500	0	1	No	3
39	1LT	26	475	0	0	No	0
129	1LT	24	600	0	0	Yes	0
131	1LT	24	420	0	0	No	0
132	1LT	28	435	0	2	No	3
135	1LT	30	550	0	0	No	4
145	CPT	24	408	0	3	Yes	3

APPENDIX C
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 3rd STRATUM
(601-800 Flight Hours, n=8, N-52)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
27	700	10	0	10	5	15	5	15	15
43	800	0	0	10	5	10	5	30	15
102	650	0	0	0	0	0	5	5	10
103	650	0	0	0	5	5	5	5	15
112	750	10	0	30	30	30	15	10	15
114	770	0	0	10	10	15	5	0	20
117	735	5	0	10	0	20	10	10	40
143	650	0	0	0	5	10	10	10	0
Sum	5705	25	0	70	60	105	60	85	130
Mean	713.0	3.1	0	8.8	7.5	13.1	7.5	10.6	16.3
S.D.	59.0	4.6	0	9.9	9.6	9.2	3.8	9.0	11.3
Maximum	800	10	0	30	30	30	15	30	40
Minimum	650	0	0	0	0	0	5	0	0
Median	718.0	0	0	10.0	5.0	12.5	5.0	10.0	15.0
Median, S.D.	34.6	2.9	0	2.9	2.9	4.3	1.4	2.9	2.9

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C

SUBJECT BACKGROUND DATA FOR THE 3rd STRATUM
(601-800 Flight Hours, n=8, N=52)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure (Years)
27	CPT	34	700	1.0	6	No	5
43	CPT	26	800	0	0	Yes	2
102	CPT	34	650	1.0	2	Yes	8
103	CPT	28	650	0	0	Yes	3
112	1LT	26	750	0	0	Yes	2
116	CPT	30	770	0	0	No	0
117	CW2	26	735	0	0	No	0
143	1LT	24	650	0	0	No	0

APPENDIX C
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 4th STRATUM
(901-1000 Flight Hours, n=10, N=72)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
24	1000	10	5	5	10	15	5	25	15
34	1000	0	5	0	10	15	15	5	10
56	1000	0	0	0	0	5	0	10	10
74	850	10	0	20	5	15	5	45	35
76	1000	10	5	5	5	5	5	10	0
104	860	20	10	10	5	15	5	10	20
110	1000	10	10	10	5	25	25	20	35
134	809	5	0	5	5	10	5	20	30
136	850	5	0	5	5	0	0	10	15
138	845	5	5	0	5	10	10	15	15
Sum	9214	75	40	60	55	115	75	170	185
Mean	921.4	7.5	4.0	6.0	5.5	11.5	7.5	17.0	18.5
S.D.	83.9	5.9	3.9	6.1	2.8	7.1	7.5	11.6	11.6
Maximum	1000	20	10	20	10	25	25	45	35
Minimum	809							5	
Median	930.0	7.5	5.0	5.0	5.0	12.5	5.0	12.5	15.0
Median, S.D.	43.3	1.4	1.4	2.9	0	2.9	1.4	2.9	5.8

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C

SUBJECT BACKGROUND DATA FOR THE 4th STRATUM
(801-1000 Flight Hours, n=10, N=72)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
24	CPT	32	1000	0	5	No	3
34	CW2	26	1000	0	2	No	0
56	CPT	32	1000	0	0	Yes	0
74	CPT	30	850	1.0	0	No	0
76	CPT	26	1000	0	4	Yes	4
104	CPT	30	860	0	0	No	8
110	MAJ	41	1000	0	0	No	5
134	CPT	34	809	0	5	No	0
136	CPT	32	850	2.0	1	No	1
138	CPT	28	845	0	0	Yes	0

APPENDIX C*
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 5th STRATUM
(1001-2000 Flight Hours, n=27, N=296)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
3	1800	15	5	15	5	35	10	5	15
10	1337	20	25	20	10	15	15	25	15
11	1280	0	15	0	10	10	15	25	10
25	1600	0	0	5	10	10	10	0	0
28	2000	0	5	5	10	5	5	10	25
32	1350	0	0	45	0	40	30	5	10
33	2000	0	5	0	5	0	5	5	5
37	1150	5	10	10	15	10	10	0	25
46	1005	0	0	25	45	45	45	30	20
50	1360	0	0	0	5	5	5	20	15
51	1612	0	0	0	0	5	0	10	10
52	1500	0	0	20	30	5	10	35	10
60	1845	45	50	70	70	60	70	60	65
61	1200	5	10	5	10	10	15	10	25
62	1200	0	0	15	15	15	5	5	10
66	1540	5	15	10	15	30	25	15	20
69	1100	5	10	10	10	15	10	20	15
73	1350	5	0	60	10	60	55	40	65
81	1525	0	0	10	15	25	10	20	35
82	1700	15	25	15	25	20	35	40	15
105	1500	15	0	35	5	30	0	10	35
111	1555	5	0	5	10	5	10	5	15
115	1795	5	0	10	5	10	0	5	5
116	1900	0	0	5	0	5	0	10	10
121	2000	5	0	5	5	0	0	0	0
122	1250	5	5	15	5	10	0	5	5
137	1700	10	10	25	25	20	20	15	15

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX CONTINUED
ON NEXT PAGE

APPENDIX C[2] (CONTINUED)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
Sum	41154	165	190	440	370	500	415	430	495
Mean	1524.2	6.1	7.0	16.3	13.7	18.5	15.4	15.9	18.3
S.D.	291.4	9.6	11.4	17.7	15.0	16.9	17.8	14.7	16.1
Maximum	2000	45	50	70	70	60	70	60	65
Minimum	1005	0	0	0	0	0	0	0	0
Median	1525.0	5.0	0	10.0	10.0	10.0	10.0	10.0	15.0
Median, S.E.	101.2	1.4	2.9	2.9	2.9	2.9	2.9	4.3	2.9

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C

SUBJECT BACKGROUND DATA FOR THE 5th STRATUM
(1001-2000 Flight Hours, n=27, N=296)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
3	CPT	32	1800	0	3	No	2
10	CPT	38	1337	0	5	No	1
11	CPT	34	1280	0	0	No	0
25	CPT	32	1600	0	4	Yes	10
28	LTC	42	2000	2.0	7	No	5
32	1LT	26	1350	0	0	No	0
33	CW3	28	2000	0	0	No	0
37	CPT	32	1150	0	3	No	5
45	CPT	28	1005	1.0	0	No	3
50	CPT	28	1360	0	2	No	2
51	CW3	28	1612	0	0	No	0
52	CW2	24	1500	0	0	Yes	0
60	MAJ	34	1845	0.5	3	No	16
61	CPT	32	1200	0	0	No	2
62	CPT	32	1200	0	1	No	3
66	CPT	34	1540	1.0	1	No	4
69	CW2	28	1100	1.0	0	No	0
73	CPT	32	1350	1.0	0	Yes	3
81	CPT	30	1525	0	0	No	0
82	CPT	28	1700	0	2	Yes	3
105	CPT	30	1500	0	4	Yes	10
111	MAJ	34	1555	0	1	No	3
115	CPT	32	1795	0	3	No	3
118	CW2	26	1900	0	0	Yes	0
121	CW2	30	2000	1.5	0	No	0
122	CW2	24	1250	0	0	No	0
137	1LT	28	1700	1.5	1	No	0

APPENDIX C[22]
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 6th STRATUM
(2001-3000 Flight Hours, n=37, N-229)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
2	2600	10	10	10	5	50	20	10	40
7	3002	15	25	10	20	30	20	55	30
8	2085	0	0	0	10	15	5	25	10
15	2400	0	5	5	15	10	15	15	25
19	2250	0	0	0	0	0	5	5	5
26	3000	5	5	15	10	20	20	5	5
29	2200	0	5	0	10	5	0	0	5
30	2400	10	5	50	40	35	45	35	40
31	2600	0	0	15	0	5	5	15	5
36	2310	5	5	10	10	15	20	25	30
42	2935	10	20	25	25	15	20	25	35
46	2995	10	15	15	10	5	5	30	30
48	2060	10	5	5	10	5	5	5	5
55	2900	5	10	5	25	35	40	35	45
59	3000	5	0	0	0	5	0	10	20
65	2680	25	30	45	35	60	60	85	100
67	2856	15	15	35	40	45	50	75	45
70	2500	0	5	10	5	25	10	25	15
72	2001	10	5	5	0	0	0	0	5
79	3000	5	0	5	0	5	0	20	5
80	2350	0	0	5	5	20	10	10	45
84	2260	5	5	5	10	10	10	25	15
85	2500	5	5	5	0	25	5	15	10
86	2920	10	0	10	5	20	5	5	15
88	3000	0	5	15	10	35	25	30	65
90	2265	15	5	20	15	15	5	30	15
93	2200	5	15	5	5	5	5	20	10
98	2800	5	5	15	5	35	15	20	15

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX CONTINUED
ON NEXT PAGE

APPENDIX "A" (CONTINUED)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
101	3000	5	0	5	0	15	15	10	10
109	2250	10	15	5	5	10	15	40	30
113	2100	0	0	0	0	0	0	0	0
114	2400	5	5	0	0	10	10	5	35
120	2700	10	5	5	15	15	10	20	35
124	3000	0	5	10	5	10	5	10	20
139	2300	5	20	10	30	15	70	90	30
140	2300	5	0	25	0	65	10	25	55
142	2837	5	0	0	0	0	0	0	5
Sum	93956	230	255	405	370	685	560	855	905
Mean	2539.4	6.2	6.9	10.9	10.0	18.5	15.1	23.1	24.5
S.D.	343.3	5.6	7.6	11.9	11.6	16.7	17.1	22.1	20.8
Maximum	3000	25	30	50	40	65	70	90	100
Minimum	2001	0	0	0	0	0	0	0	0
Median	2500.0	5.0	5.0	5.0	5.0	15.0	10.0	20.0	20.0
Median, S.D.	112.6	0	0	1.4	1.4	2.9	2.9	4.3	4.3

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C[19]

SUBJECT BACKGROUND DATA FOR THE 6th STRATUM
(2001-3000 Flight Hours, n=37, N=229)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
2	MAJ	36	2600	1.0	2	Yes	10
7	CPT	32	2002	0	1	Yes	10
8	MAJ	34	2085	0	0	No	2
13	MAJ	34	2400	0	4	Yes	8
19	CW3	32	2250	1.0	0	No	0
26	CW3	36	3000	0	0	No	0
29	CW2	32	2200	0	0	No	0
30	MAJ	40	2400	0	9	No	9
31	CPT	28	2600	0.5	0	No	0
36	1LT	32	2310	0	0	Yes	0
42	CW2	32	2935	1.5	1	No	8
46	1LT	28	2995	2.0	0	No	5
48	CPT	28	2060	0	0	Yes	1
55	CPT	38	2900	0	0	No	1
59	CW3	30	3000	0	0	Yes	12
65	MAJ	38	2680	0	3	No	5
67	COL	45	2856	0	11	No	8
70	LTC	41	2500	0	2	No	5
72	CW2	32	2001	1.0	0	No	0
79	CW3	32	3000	0	1	No	1
80	CW2	32	2350	0	0	No	0
84	CW2	26	2260	0	0	No	0
85	CW2	24	2500	0	1	No	8
86	CW3	30	2920	1.0	0	Yes	0
88	CW2	34	3000	1.5	0	Yes	3

APPENDIX CONTINUED ON NEXT PAGE

APPENDIX C-[illegible] (CONTINUED)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
90	CPT	28	2265	0	0	Yes	2
93	CW2	34	2200	0	5	No	5
98	1LT	28	2800	1.0	0	Yes	0
101	CW3	38	3000	0	0	No	0
109	CPT	32	2250	2.0	0	Yes	2
113	CW3	30	2100	1.5	0	No	0
114	CPT	30	2400	2.0	0	No	0
120	CW3	32	2700	0	0	No	0
124	CW3	34	3000	0	0	No	0
139	LTC	47	2300	0	0	Yes	0
140	CW3	34	2300	1.0	2	Yes	10
142	CW3	30	2837	0	0	No	1

APPENDIX C[cont.]
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 7th STRATUM
(3001-4000 Flight Hours, n=26, N=100)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
1	3100	0	0	15	15	10	15	20	15
4	3800	0	5	40	5	60	5	0	70
14	4000	0	0	0	0	5	25	30	30
17	3280	10	5	5	10	30	15	25	45
21	3400	5	5	10	5	5	5	15	35
35	3740	10	0	10	0	15	15	15	15
44	3220	15	15	45	35	45	45	35	35
49	3650	15	0	20	10	55	50	60	65
57	3280	0	0	0	0	10	25	20	75
58	3700	0	5	10	5	15	15	15	10
63	3400	25	20	25	30	30	25	30	35
64	3250	40	35	45	55	70	65	50	75
68	3425	0	0	20	15	55	55	95	95
71	3145	5	10	20	20	15	20	35	35
75	4000	15	20	10	20	10	55	15	20
78	3089	10	5	5	5	10	25	30	15
87	3995	0	0	15	0	10	0	10	15
91	3225	0	0	0	0	0	5	0	5
92	3500	10	5	15	15	15	10	10	25
97	3222	15	10	20	10	15	5	15	15
99	3235	0	0	20	25	25	15	30	25
100	3300	5	0	10	0	10	0	5	15
108	3113	0	0	35	5	50	5	5	25
119	3100	15	10	20	15	30	15	25	20
123	3050	5	5	5	5	5	0	25	20
144	3800	0	5	40	5	60	5	0	70

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX CONTINUED
ON THE NEXT PAGE.

APPENDIX C[13] (CONTINUED)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
Sum	89019	200	160	460	310	660	520	615	905
Mean	3423.8	7.7	6.2	17.7	11.9	25.4	20.0	23.7	34.8
S.D.	309.1	9.6	8.4	13.6	13.0	21.0	18.9	20.7	24.6
Maximum	4000	40	35	45	55	70	65	95	95
Minimum	3050	0	0	0	0	0	0	0	5
Median	3290.0	5.0	5.0	15.0	7.5	15.0	15.0	20.0	25.0
Median, S.D.	79.4	2.9	1.4	2.9	2.9	5.8	5.8	4.3	4.3

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C-1

SUBJECT BACKGROUND DATA FOR THE 76K STRATUM
(3001-4000 Flight Hours, n=26, N=168)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
1	CW2	34	3100	1.5	0	No	1
4	CW3	30	3800	1.0	1	No	1
14	CW3	32	4000	0	0	No	0
17	CW2	38	3280	0	10	No	10
21	CW3	32	3400	1.5	2	Yes	2
35	CW3	30	3740	0	10	Yes	10
44	CW3	32	3220	0	1	Yes	1
49	CW3	34	3650	1.0	0	Yes	0
57	LTC	42	3280	0	6	Yes	0
58	COL	45	3700	2.0	4	No	8
63	CW4	40	3400	0	0	No	0
64	CW3	34	3250	0	2	Yes	2
68	CW3	34	3425	0	2	No	16
71	CW3	32	3145	0	0	No	0
75	CW3	36	4000	0	0	No	0
78	CW2	26	3089	2.0	0	No	0
87	CW3	28	3995	2.0	0	No	0
91	CW3	32	3225	0	1	No	5
92	CW3	32	3500	1.0	0	No	0
97	CW4	34	3222	0	0	No	0
99	LTC	44	3235	0	2	No	5
100	CPT	32	3300	0	0	No	12
108	CW3	36	3113	0.5	1	No	3
119	MAJ	38	3100	0	0	No	0
123	CW3	32	3050	2.0	0	No	0
144	CW3	30	3800	0	0	No	1

APPENDIX C
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 8th STRATUM
(4001-5000 Flight Hours, n=13, N=85)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
9	4500	0	10	0	10	10	10	30	20
12	4500	0	20	5	20	30	30	30	70
15	4070	5	0	0	0	5	5	15	5
16	4550	5	0	20	5	20	5	30	20
18	4070	5	5	0	5	65	30	60	85
38	4300	5	5	5	5	15	5	10	25
40	4910	0	0	5	0	5	5	0	5
41	4500	5	5	5	5	10	5	0	5
54	4650	5	0	20	15	20	5	10	20
83	4600	0	10	15	40	30	35	25	40
94	4700	5	0	0	0	25	15	5	15
106	4521	5	35	35	60	50	65	55	45
127	4250	15	10	25	10	35	10	10	35
Sum	58121	55	100	135	175	320	225	280	390
Mean	4470.8	4.2	7.7	10.4	13.5	24.6	17.3	21.5	30.0
S.D.	242.3	4.0	10.1	11.4	17.7	17.7	18.1	19.3	24.8
Maximum	4910	15	35	35	60	65	65	60	85
Minimum	4070	0	0	0	0	5	5	0	5
Median	4500	5.0	5.0	5.0	5.0	20.0	10.0	15.0	20.0
Median, S.D.	86.6	1.4	2.9	5.8	2.9	5.8	7.2	5.6	7.2

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C[illegible]

SUBJECT BACKGROUND DATA FOR THE 8th STRATUM
(3001-5000 Flight Hours, n=13, N=85)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
9	CW4	41	4500	1.5	0	No	2
12	MAJ	41	4500	0	10	No	0
15	CW3	32	4070	0	0	Yes	1
16	CW2	36	4550	0	2	No	0
18	CW3	32	4070	1.5	1	Yes	2
38	CW2	30	4300	0	0	No	0
40	CW3	32	4910	0	0	No	11
41	CW2	34	4500	1.0	0	No	0
54	CW3	34	4650	1.5	0	No	0
93	CW3	32	4600	0	0	[illegible]	0
94	CW3	32	4700	0	2	No	6
106	CW4	44	4521	0	0	No	10
127	CW3	30	4250	1.5	0	Yes	2

APPENDIX C[17]
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 9th STRATUM
(5001-6000 Flight Hours, n=5, N-39)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
5	5050	0	15	10	10	20	20	25	20
6	5200	5	5	5	5	20	5	10	5
20	5440	0	15	15	5	55	10	10	50
53	5100	25	5	30	15	30	10	20	35
107	5200	0	0	5	0	0	0	5	15
Sum	25990	30	40	65	35	125	45	70	125
Mean	5198.0	6.0	8.0	13.0	7.0	25.0	9.0	14.0	25.0
S.D.	150.1	10.8	6.7	10.4	5.7	20.0	7.4	8.2	17.7
Maximum	5440	25	15	30	15	55	20	25	50
Minimum	5050	0	0	5	0	0	0	5	5
Median	5200.0	0	5.0	10.0	5.0	20.0	10.0	10.0	20.0
Median, S.D.	112.6	7.2	4.3	7.2	4.3	15.9	5.8	5.8	13.0

* Identified by subject number.
** The L and R denote the left and right ears, respectively.

APPENDIX C

SUBJECT BACKGROUND DATA FOR THE 5th STRATUM
(5001-6000 Flight Hours, N=5)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure (Years)
5	CW3	40	5050	0	0	No	0
6	CPT	41	5200	0	0	No	15
20	CW3	32	5440	0	0	No	0
53	MAJ	40	5100	0	0	Yes	3
107	CW3	34	5200	0	0	No	0

APPENDIX C[illegible]
(Data and Summary Statistics)

HEARING LOSS IN DECIBELS FOR THE 10th STRATUM
(6001-7000 Flight Hours, n=2, N=9)

* Subject Number	Flight Hours	** L 2000 Hz	R 2000 Hz	L 3000 Hz	R 3000 Hz	L 4000 Hz	R 4000 Hz	L 6000 Hz	R 6000 Hz
126	7000	5	0	10	20	20	25	55	25
130	7000	5	0	50	10	55	0	20	40
Sum	14000	10	0	60	30	75	25	75	65
Mean	7000.0	5.0	0	30.0	15.0	37.5	12.5	37.5	32.5
S.D.	0	0	0	28.3	7.1	24.7	17.7	24.7	10.6
Maximum	7000	5	0	50	20	55	25	55	40
Minimum	7000	5	0	10	10	20	0	20	25
Median	7000.0	5.0	0	30.0	15.0	37.5	12.5	37.5	32.5
Median, S.D.***	7000.0								

* Identified by subject number.
** The L and R denote the left and right ears, respectively.
***Strata 10 sample size is too small, SE not computed.

APPENDIX C-6

SUBJECT BACKGROUND DATA FOR THE 10th STRATUM
(6001-7000 Flight Hours, [illegible], N=9)

Subject Number	Rank	Age	Flight Hours	Smoke (Pack/Day)	Artillery Exposure/ (Years)	SPH-4 Helmet Worn with Earplugs	Small Arms Exposure/ (Years)
126	CW3	38	7000	[illegible]	1	No	19
130	CW2	34	7000	2.5	4	No	5

APPENDIX D

List of Manufacturers

APPENDIX D

LIST OF MANUFACTURERS

Grason-Stadler Inc.
56 Winthrop Street
Concord, Massachusetts 01742

Industrial Acoustics Corporation
380 Southern Boulevard
Bronx, New York 10454

Systems Engineering Division, Gould Inc.
6901 W. Sunrise Boulevard
Fort Lauderdale, Florida 33313

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5001 Eisenhower Avenue
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220 7th St., NE
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MAJ J. Soutendam (Ret)
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